

On-Road Motor Vehicles

EMFAC2007 Working Draft

Dilip Patel

EMFAC2007 Working Draft

Summary of Changes

Changes	Statewide Changes For 2015 calendar year	ROG_Tot ¹	CO_Tot	NOx_Tot	PM10_Tot ²
0	Baseline - EMFAC2002 ver2.2 Version 2.208	378.64	3396.17	673.81	51.79
1,4,7	● Fuel Correction Factors – Phase 3 and low sulfur	-5.49	24.31	17.46	-0.61
2	● I&M Updates – Change of ownership, new enhanced areas, etc.,	-4.96	-76.32	-4.72	0.00
4	● Brakewear	0.00	0.00	0.00	0.59
	Activity Updates				
5	● Accrual Rates	0.01	-50.21	-9.31	-1.33
6	● VMT Matching by Fuel Type	-2.82	-2.05	2.07	0.12
10,23	● New Populations for 2000-2003 calendar years, 2004-2005 added later	174.50	1304.33	219.49	15.02
11	● Redistribution of heavy heavy-duty diesel vehicle populations	-0.01	1.34	-19.95	-0.22
15, 21, 24	● Updated base-year and forecast year VMTs (33 areas, including SCAG)	-47.45	-757.22	-107.31	-12.59
16, 25	● Corresponding changes to speed distribution files	5.07	52.44	11.33	1.16
13	● Ethanol permeation - from fuel sold beginning 2004 calendar year	14.01	-0.02	0.00	0.00
	● Updated Heavy-Heavy-Duty Diesel exhaust rates, idle (low & high), and				
14	speed corrections	17.40	27.38	112.30	4.36
	● Temperatures – new summer profiles corresponding to the federal 8-hour				
18	Ozone standard	39.83	138.40	-32.04	0.00
	● Relative Humidities – new summer relative humidity profiles corresponding to				
19	the federal 8-hour Ozone standard	-0.39	-28.62	48.44	0.00
3,12,22	● Bug Fixes, Regime Specific Evap Calc, Corrected HDV Gas Cap	-4.11	-9.24	-0.18	2.39
	● Estimated Changes for Pending Vehicles	-59.53	-260.54	-24.33	-0.60
	● Total Inventory Changes (tons per day)	126.06	363.99	213.24	8.30
	● Percentage Increase	33.29%	10.72%	31.65%	16.03%

ROG_Tot¹ Includes exhaust, starting, idle and evaporative emissions

PM10_Tot² Includes tire wear and brake wear emissions

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Changes On Percentage Basis

Magnitude of Changes on a Percentage Basis				
Statewide Changes For 2015 calendar year	ROG_Tot ¹	CO_Tot	NOx_Tot	PM10_Tot ²
● Fuel Correction Factors – Phase 3 and low sulfur	-4.4%	6.7%	8.2%	-7.4%
● I&M Updates – Change of ownership, new enhanced areas, etc.,	-3.9%	-21.0%	-2.2%	0.0%
● Brakewear	0.0%	0.0%	0.0%	7.1%
● Accrual Rates	0.0%	-13.8%	-4.4%	-16.0%
● VMT Matching by Fuel Type	-2.2%	-0.6%	1.0%	1.4%
● New Populations for 2000-2003 calendar years, 2004-2005 added later	138.4%	358.3%	102.9%	180.9%
● Redistribution of heavy heavy-duty diesel vehicle populations	0.0%	0.4%	-9.4%	-2.6%
● Updated base-year and forecast year VMTs (33 areas, including SCAG)	-37.6%	-208.0%	-50.3%	-151.6%
● Corresponding changes to speed distribution files	4.0%	14.4%	5.3%	14.0%
● Ethanol permeation - from fuel sold beginning 2004 calendar year	11.1%	0.0%	0.0%	0.0%
● Updated Heavy-Heavy-Duty Diesel exhaust rates, idle (low & high), and speed corrections	13.8%	7.5%	52.7%	52.5%
● Temperatures – new summer profiles corresponding to the federal 8-hour Ozone standard	31.6%	38.0%	-15.0%	0.0%
● Relative Humidities – new summer relative humidity profiles corresponding to the federal 8-hour Ozone standard	-0.3%	-7.9%	22.7%	0.0%
● Bug Fixes, Regime Specific Evap Calc, Corrected HDV Gas Cap	-3.3%	-2.5%	-0.1%	28.8%
● Estimated Changes for Pending Vehicles	-47.2%	-71.6%	-11.4%	-7.2%
		Greater than 10% Decrease		
		10-30% Increase		
		Greater than 30% Increase		

Fuel Correction Factor- *Updates*

Lead Staff: Ben Hancock

On-Road Fuel Correction Factors

- BER – Emissions from vehicle during standardized testing (*temperature, fuel, speed, relative humidity, air conditioning*)
- $A_{dj}\text{-BER} = \text{BER} * \text{SCF}_{\text{speed}} * \text{FCF}_{\text{fuel}} * \text{TCF}_{\text{temp}}$
- $\text{FCF}_{\text{fuel}} = \frac{\text{Emissions}_{\text{From Fuel Used}}}{\text{Emissions}_{\text{When Tested}}}$
- FCF vary by gasoline and diesel vehicles, by technology type
- Gasoline – Running/Starting HC, CO, NOx
- Diesel – Running NOx, PM

Gasoline Fuel Correction Factors

- Modified the Phase 2 FCFs to reflect cumulative benefits
- Eliminated the benefit previously given to vehicles introduced after the availability of reformulated gasoline

EMFAC2002 Exhaust (FCF) for Cleaner-Burning Gasoline

Cal Year	Model Year	Summertime			Wintertime		
		HC*	CO	NOx	HC*	CO	NOx
Pre-92	All	1.000	1.000	1.0000	1.000	1.000	1.0000
1992-95	All	0.988	0.994	0.9970	0.963	0.895	0.9970
1996-03	All	0.860	0.890	0.8900	0.860	0.890	0.8900
2004+	All	0.860	0.890	0.8695	0.860	0.890	0.8695

FCFs For Cleaner Burning Gasoline in EMFAC2007

Cal Year	Model Year	Summertime			Wintertime		
		HC	CO	NOx	HC	CO	NOx
		Pre-Cleaner Burning Gasoline					
Pre-92	All	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		RFG I					
1992-95	Pre-1992	0.9880	0.9940	0.9970	0.9630	0.8950	0.9970
1992-95	1992-1995	1.0000	1.0000	1.0000	0.9630	0.8950	0.9970
		RFG II					
1996-03	Pre-1992	0.8500	0.8840	0.8873	0.8500	0.8840	0.8873
1996-03	1992-1995	0.8600	0.8900	0.8900	0.8600	0.8900	0.8900
1996-03	1996+	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		RFG III					
2004+	Pre-1992	0.8500	0.8840	0.8669	0.8500	0.8840	0.8669
2004+	1992-1995	0.8600	0.8900	0.8695	0.8600	0.8900	0.8695
2004+	1996-03	1.0000	1.0000	0.9770	1.0000	1.0000	0.9770
2004+	2004+	1.0000	1.0000	0.9770	1.0000	1.0000	0.9770

Update Diesel FCF

- Revised PM / NO_x FCF — *Cleaner Burning Diesel Fuel (CBD) beginning 1994*
- Updated PM / NO_x FCF — *Ultra-Low Sulfur Diesel Fuel beginning 2007*
- Added Hydrocarbon Benefits — *Previously no HC benefits associated with CBD*
- Added FCF benefits to Idle emissions — *Previously no benefits given to idle emissions*

Out-of-State - *Diesel Fuel Usage*

- Line Haul Vehicles — *either fuel-up out-of-state or consume federal fuel in California*
- Staff estimated 10% of the diesel consumed in CA is federal fuel. *Three sources for this estimate*
 - International Fuel Tax Agreement
 - Board of Equalization fuel sales records
 - US Dept of Census Truck Inventory and Use Survey
- Federal HHDT Technology Groups — *modified FCFs to reflect correct fuel usage*

Clean Diesel FCF in EMFAC2002

Cal Year	Model Year	SCAB & Ventura		Not SCAB & Ventura	
		NOx	PM	NOx	PM
Pre-1985	All	1.000	1.000	1.000	1.0000
1985-1993	Pre-1991	1.000	0.9610	1.000	1.0000
1994-2006	Pre-1991	0.944	0.7940	0.944	0.7940
2007+	Pre-1991	0.944	0.7622	0.944	0.7622
1985-1993	1991-1993	1.000	0.7730	1.000	1.0000
1994-2006	1991-1993	0.876	0.6720	0.876	0.6720
2007+	1991-1993	0.876	0.6451	0.876	0.6451
1994-2006	1994-2006	0.876	0.8990	0.876	0.8990
2007+	1994-2006	0.876	0.8630	0.876	0.8630
2007+	2007+	0.876	0.8990	0.876	0.8990

Diesel FCFs in EMFAC2007

Cal Year	Model Year	SCAB and Ventura			All Other Areas		
		NOx	PM	HC	NOx	PM	HC
Pre-1985	All	1.00	1.00	1.00	1.00	1.00	1.00
1985-1993	All	1.00	0.95	1.00	1.00	1.00	1.00
1994-2006	All	0.93	0.75	0.72	0.93	0.75	0.72
2007+	Pre-2007	0.93	0.72	0.72	0.93	0.72	0.72
2007+	2007+	0.93	0.80	0.72	0.93	0.80	0.72

Updates to I/M Programs

Lead Staff: Dilip Patel

Updates to I/M Programs

- Correctly Model Change of Ownership (COR) programs.
- Model Changes to IM Program - *beginning 2005 Calendar Year.*
- Update Default IM Assumptions – *reflect areas that have recently enhanced or adopted I&M programs*

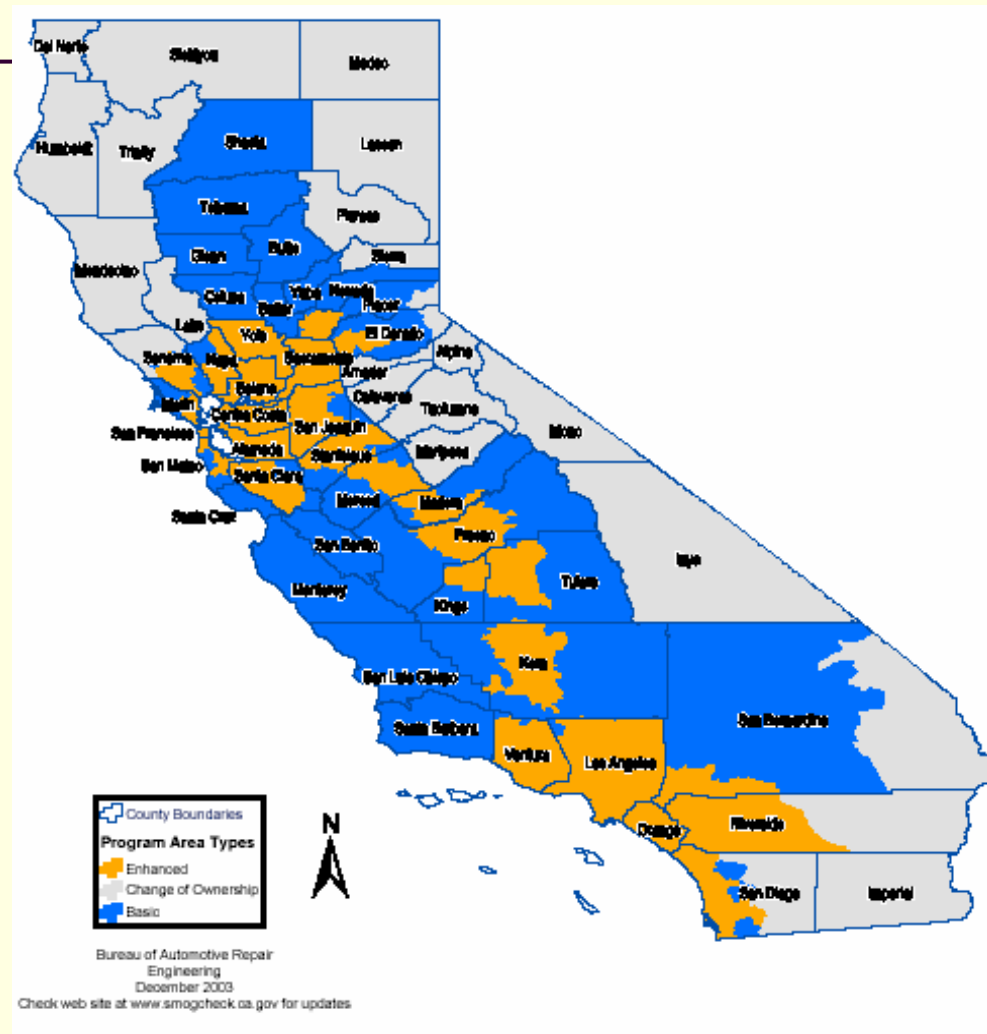
Change of Ownership (COR)

- **COR** - *Used vehicles in all areas of the State subject to smog check prior to sale (17%).*
- **EMFAC** - *Currently, COR modeled in IM areas, only, and to vehicles subject to program.*
- **Change(1)** - *Subject used vehicles in non-IM areas to COR.*
- **Change(2)** - *Include new vehicles that are exempt from IM but were still subject to COR.*

IM Program Changes - 2005

- Eliminated 30-Year Rolling Exemption – *previously vehicles up to age 30 were subject to I&M*
- 1976 Model Year – *Earliest vehicle inspected is fixed to 1976*
- New Vehicle Exemption – *New vehicles up to age 6 exempt from I&M, up to age 4 exempt from COR.*

Update Program Types by Area



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Update Areas

■ Areas Adopting Enhanced ASM Program

County Name	AB	APCD Name	Estimated % Program Type		
			Basic	COO	Enhanced (*)
El Dorado	LT	El Dorado County APCD	14.4%	17.5%	68.0%
Placer	LT	Placer County APCD	9.1%	5.3%	85.6%
Placer	MC	Placer County APCD	9.1%	5.3%	85.6%
Alameda	SF	Bay Area AQMD	0.0%	0.0%	100.0%
Contra Costa	SF	Bay Area AQMD	0.0%	0.0%	100.0%
Marin	SF	Bay Area AQMD	3.9%	0.0%	96.1%
Napa	SF	Bay Area AQMD	17.2%	0.0%	82.8%
San Francisco	SF	Bay Area AQMD	0.0%	0.0%	100.0%
San Mateo	SF	Bay Area AQMD	3.8%	0.0%	96.2%
Santa Clara	SF	Bay Area AQMD	0.0%	0.0%	100.0%
Solano	SF	Bay Area AQMD	0.0%	0.0%	100.0%
Sonoma	SF	Bay Area AQMD	10.7%	0.0%	89.3%
Kings	SJV	San Joaquin Valley APCD	18.6%	0.0%	81.4%
Madera	SJV	San Joaquin Valley APCD	28.1%	0.0%	71.9%
Merced	SJV	San Joaquin Valley APCD	26.4%	0.0%	73.6%
Tulare	SJV	San Joaquin Valley APCD	9.6%	0.0%	90.4%
Riverside	MD	Mojave Desert AQMD	0.0%	100.0%	0.0%
Riverside	MD	South Coast AQMD	0.0%	100.0%	0.0%

Brake Wear PM

Lead Staff: Ben Hancock

Brake Wear - *Varies by*

- Number of brakes per vehicle
- PM emissions per braking event
 - Function of friction material and brake type (disc or drum)
 - Function of deceleration rate (braking pedal effort) or speed
 - Function of vehicle weight or brake pad size
- Fraction of PM that becomes airborne
- Number of braking events per mile
- Type of cycle

Brake Wear PM - *Update*

- Simple Update – *Fix a calculation error on the assumed number of axles per vehicle*
- Current Methodology – *Assumes 12.8 mg/mi PM from all vehicles. However, this rate (which assumes 2 front disc and 2 rear drum brakes) was applied to all vehicles*
- Change – *For HHDVs assume 5 axles (2 disc and 8 drum brakes). Increase rate to 28.8 mg/mi PM*
- Change – *Motorcycles assume only 2 disc brakes*

Brake Wear PM - *Results*

- Applying to the VMT for HHDTs and motorcycles results in about a 0.5 tpd increase in Statewide PM in 2005 .

Statewide Brake Wear PM Inventory Effects in 2005

Class	VMT mi/d	Current		Modified	
		g/mi	tpd	g/mi	tpd
HHDT	27,636,096	0.0128	0.39	0.0288	0.87
MC	3,012,986	0.0128	0.04	0.0064	0.02
Total	872,884,116		12.30		12.77

Future Work – *Brake Wear*

- Explore modern braking materials
- Explore braking activity in modern, real-world driving cycles
- Explore how braking severity can affect the emissions

Updates to Vehicle Activity

- Accrual Rates
- Vehicle Populations
- Heavy-Heavy Diesel Truck VMT Redistribution
- VMT & Speed Updates From COG/MPOs

Accrual Rates

Lead Staff: Shamasundara Hebbalalu

Mileage Accrual Rates - *Intro*

- **Accrual** – *Miles driven per year*
Varies by: *Vehicle type, fuel used, age, area*
- **Used in:**
 - *Calculating cumulative mileage, which is then used in estimating emissions at given mileage.*
 - *Calculating $VMT_{cy} = Pop_{my} * Accrual_{my}$*
- **Last Updated** – EMFAC2000 using BAR data for 91-95 calendar years
- **Accrual rates changes** – accommodate
 - $VMT_{cog} = Pop_{my} * Accrual_{my}$

Accrual Rate - *Methodology*

- BAR data (2001-2003) – *matched 6 million records by VIN*
- Outliers – *Statewide basis, by vehicle class Odometer removed top/bottom 1% for 1990+ and top 1% for pre-1990 vehicles.*
- $\text{Accrual}_{\text{vin}} = \text{Odo_2003} - \text{Odo_2001}$
- Adjusted – *Odometer for Pre-90's (rollover algorithm*
- Calculated – *accrual rates by age, area, and vehicle classes (PC, light-trucks, light-heavy, and medium-heavy-trucks)*
- Counties with Insufficient Data - *Replaced with Adjacent County Accrual Rates*

Data Replacement

■ Counties with Insufficient Data

County	Replaced with	County	Replaced with
ALPINE	EL DORADO	AMADOR	SACRAMENTO
MONO	EL DORADO	INYO	SAN BERNARDINO
DEL NORTE	MENDOCINO	LASSEN	SHASTA
HUMBOLDT	MENDOCINO	MODOC	SHASTA
TRINITY	MENDOCINO	SISKIYOU	SHASTA
MARIPOSA	MERCED	CALAVERAS	STANISLAUS
PLUMAS	NEVADA	TUOLUMNE	STANISLAUS
SIERRA	NEVADA	COLUSA	YOLO

Results

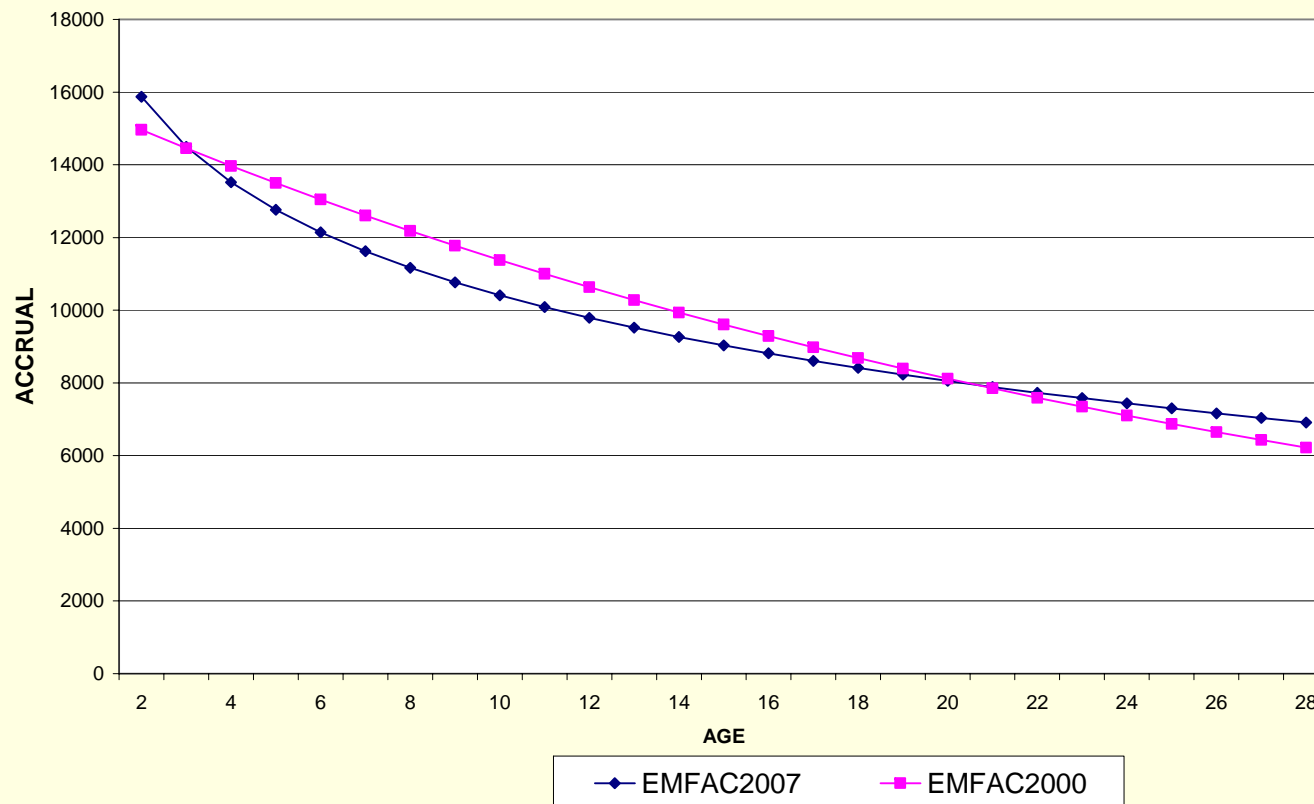
■ Regression analyses for best fit

Vehicle Classess	GVWR(lbs)	Calculation	Relation with Age
PC	all	Area-Specific	Curve - fit
Light-Trucks T1-T2	1 to 6000	Area-Specific	Curve - fit
Medium-Duty T3	6001-8500	Statewide	Curve - fit
Light-Heavy T4	8501-10000	Statewide	Curve - fit
Light-Heavy T5	10001-14000	Statewide	Curve - fit
Medium-Heavy T6	14001-33000	Statewide	Curve - fit
MotorHome	all	Statewide	Flat - no fit

- With exception to T6, accrual rates applied to gas/diesel/electric vehicles

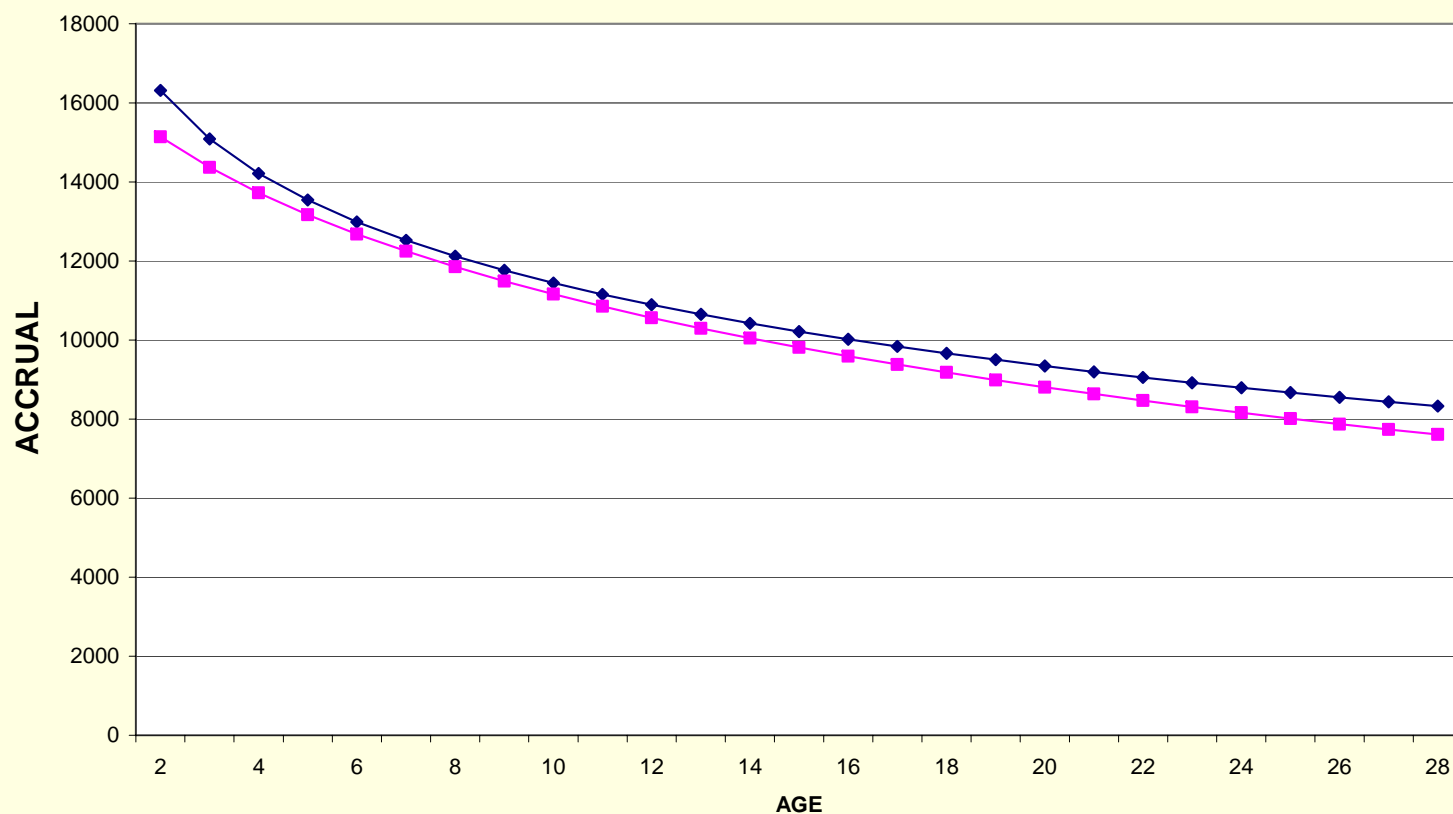
Accrual Rates - *PCs*

STATEWIDE ACCRUAL RATES FOR PCs



Accrual Rates – *T1* & *T2*

STATEWIDE ACCRUAL FOR T1&T2



Impact of Changes - *Statewide*

- Reduced Statewide VMT by 4% - 7%, - *varies by calendar year, and area*
- Emissions – *generally reduced by 1% - 6%, again varies by area*

Population Updates

Lead Staff: Alice Tong

Vehicle Population Estimates

- Population data - *California Department of Motor Vehicles (DMV) calendar years 2000-2005*
- Vehicle Classifications - *Weight data (test weight) from Bureau of Automotive Repair (BAR). Also used GVWR from DMV*
- Addition of “Other Bus” Category – *not a school bus, not an urban transit, its other bus*
- Redistribution of HHDDT Population – *statewide populations redistributed in proportion to HHDDT VMT*

EMFAC2002 - *populations*

- Base population – *1999 calendar year*
- Backcasts / Forecasts – *1999*
- Excluded all “Pending” Vehicles – *those that attempted to register but their status was undetermined*
- Excluded all Alternatively Fueled Vehicles
- Excluded Vehicles Older than 45 Years
- Excluded all Out-of-State Vehicles – *registered in CA but have mailing addresses outside*

EMFAC2007 – *working draft (1st)*

- Base population – *2000-2005 calendar years*
- Backcasts form 2000 & Forecasts from 2005
- Included all “Pending” Vehicles
- Excluded all Alternatively Fueled Vehicles
- Excluded Vehicles Older than 45 Years
- Excluded all Out-of-State Vehicles

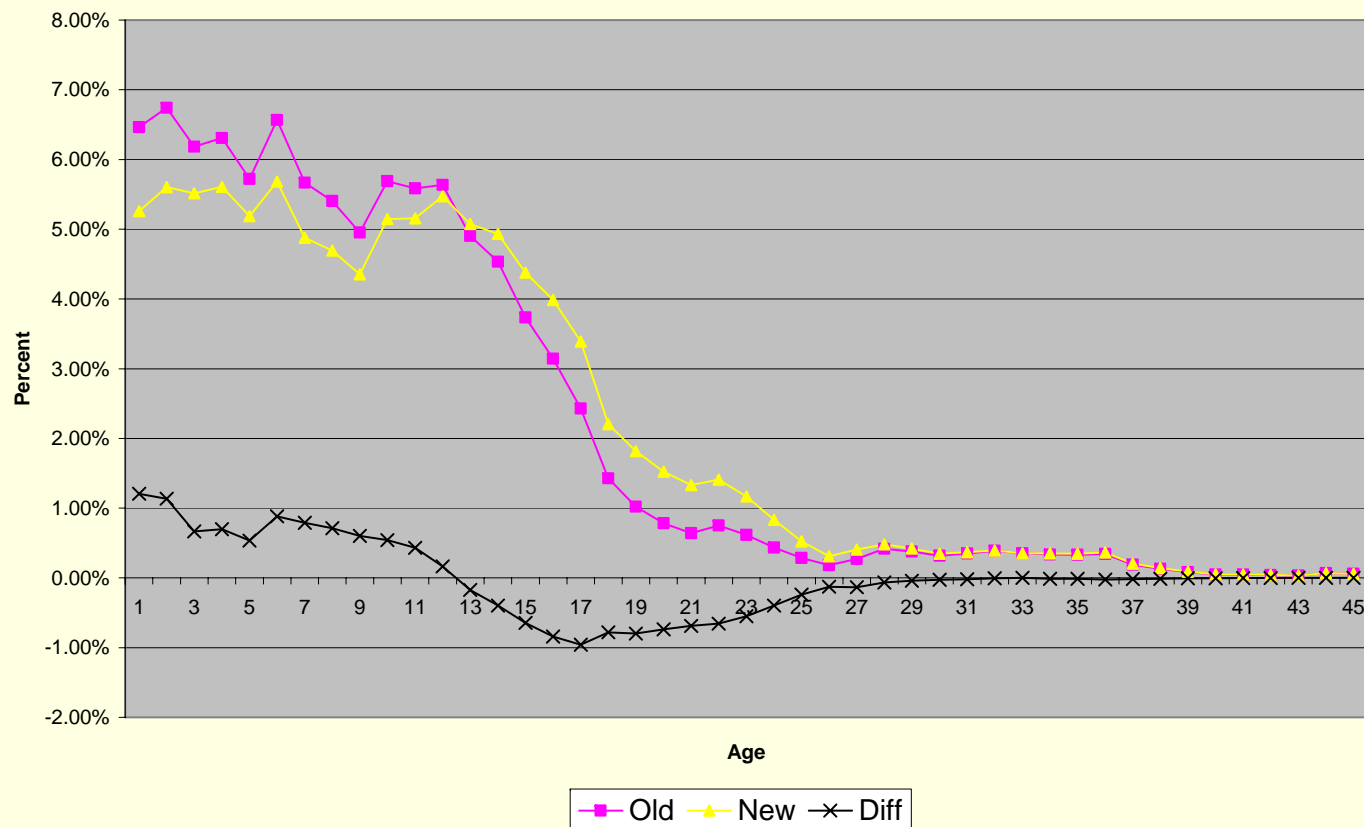
Pending Issue

- Significant population increases
- Increases in average age of the fleet

Population Changes from First Analysis			
	Old_2000	New_2000	Percent Increase
PC	12518632	15601434	24.63%
T1	3335065	3389467	1.63%
T2	3421867	4546265	32.86%
T3	1508653	1487687	-1.39%
T4	234903.4	294518	25.38%
T5	77045.49	158872	106.21%
T6	229650.3	237316	3.34%
T7	187423.3	135562	-27.67%
Obus	0	16101	
Ubus	25787.06	10082	-60.90%
MCY	388527.4	495857	27.62%
Sbus	24008.16	20616	-14.13%
Mhome	271522.7	313633	15.51%
Total	22223084	26707410	20.18%

Pendings – *Effect on Distributions*

PC-Gas Age Distributions For 2000 CY



Pendings - *Solution*

- Currently *re-analyzing all population data*
- Registered – *count all registered populations*
- Pending adjustment – *look at subsequent DMV datasets & count the pending vehicles that actually register (time consuming)*
- Total Population = Registered + Pending adjustment
- Chronic Pendings – *assume these vehicles moved out-of-state or scrapped*

EMFAC2007 – *final estimates*

- Include – *some pending vehicles*
- Include - *Hybrids*
- Exclude – *CNG, LPG fueled vehicles. Most appear to have non-road applications*
- Include – *Vehicles older than 45. Caveat will have to check how this will affect backcasting*
- Exclude – *all out-of-state vehicles. May be students or military and hence not operating in CA.*

Population Summary

- Staff is still assessing, but the net will probably be a 4-5% (1 million) increase.
- This will result in an increase in Evaporative and Starting emissions, but little exhaust effect (tied to VMT, not population).
- Staff working with DMV to “clean” the data set.

HHDT VMT Redistribution

Lead Staff: Augustus Pela, Pranay Avlani,
& Seungju Yoon

HHDDT VMT Redistribution

- Why Redistribute?
 - EMFAC 2002 allocated VMT by location of truck registration. ($Pop_{registered_area} * Accrual\ Rate = VMT_{area}$)
 - But heavy-heavy duty diesel trucks travel far from their registered location
- What was changed?
 - Revised EMFAC VMT allocation is by miles of travel
 - More accurately reflects driving patterns in California
- VMT redistributed from urban areas to rural areas
 - Decreased VMT in South Coast and Bay Area
 - Increased VMT in SJV and Mojave Desert

HHDDT VMT Redistribution

- How was real-world truck travel estimated?
 - Evaluated a major statewide survey of truck travel (8,000 trucks) conducted by Caltrans, 2001
 - Used GIS to estimate probable mileage based on origin/destination data
 - Summed estimated mileage and calculated percentage of survey travel by county
 - Compared results to MVSTAFF

HHDDT VMT Redistribution

- How was the change made in EMFAC?
 - Redistributed HHDT population in proportion to travel in each area
 - Assume statewide mileage accrual rates
 - Apply county-level growth estimates – *based on MVSTAFF*

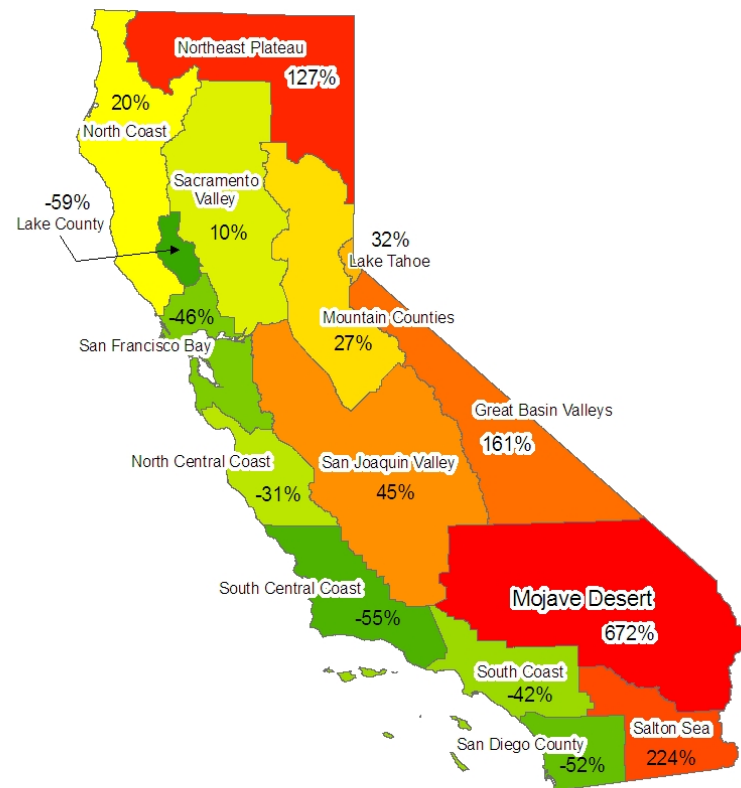
HHDDT Redistribution - *Results*

■ Year 2000 HHDDT VMT

Air Basin	EMFAC 2002		Current Model	
	VMT	Percentage	VMT	Percentage
Great Basin Valley	35,000	0.1%	152,000	0.6%
Lake County	23,000	0.1%	12,000	0.04%
Lake Tahoe	13,000	0.1%	19,000	0.1%
Mojave Desert	362,000	2%	4,063,000	15%
Mountain Counties	254,000	1%	481,000	2%
North Central Coast	600,000	2%	477,000	2%
North Coast	316,000	1%	375,000	1%
Northeast Plateau	74,000	0.3%	393,000	1%
Sacramento Valley	2,229,000	9%	2,576,000	10%
Salton Sea	444,000	2%	1,762,000	7%
San Diego	1,807,000	7%	1,016,000	4%
San Francisco	4,164,000	17%	2,107,000	8%
San Joaquin	4,245,000	18%	7,780,000	29%
South Central Coast	634,000	3%	351,000	1%
South Coast	8,900,000	37%	5,389,000	20%
Total	24,100,000	100%	26,953,000	100%

HHDDT VMT Redistribution

Fig 1: Percent Change in Heavy Heavy Duty VMT for year 2010



VMT & Speed Updates

Lead Staff: Pam Burmich & Agnes
Dugyon

Activity – VMT & Speeds

- Modify the model to reflect the latest speed and VMT submissions from transportation planning agencies (TPAs)
- Apply quality assurance procedures to review of motor vehicle activity

Vehicle Activity Updates

Activity Data Updated in EMFAC 2007		Planned
	EMFAC WD2B	EMFAC 2007
Region	Nov 04 - May 06	Sept 06
AMBAG (Monterey)	X	
BCAG (Butte)	X	
San Joaquin Valley TPAs	X	
MTC (Bay Area)	X	X
SACOG (Sacramento)	X	
SANDAG (San Diego)	X	X
SCAG (South Coast)	X	X
SBCAG (Santa Barbara)	X	
TRPA (Lake Tahoe) (speeds only)	X	

QA Procedures

- Compare VMT and speeds to prior submittals
- Compare to independent data sources (i.e., MVSTAFF, DMV, DOF)
- Examine changes over time and time-of-day
- Discuss anomalies/issues with TPAs; gain agreement on any adjustments
- Document findings and TPA responses

Activity Updates - *Model*

- Base Years (2000-2005); $VMT = Population * Accrual_Rates$
 - *Accrual_Rates are modified to match Base-Year-VMTs from COGs. Note, can only match vmt for one base year in each area*
- Forecast Years
 - $Forecasted\ VMT = Forecasted_population * Accrual_Rates$
 - $Forecasted_Population = Fn(population\ growth\ rates)$
 - $Population_growth_rates = Fn(Forecasts\ of\ VMT\ from\ COGs)$
- For forecast years, population growth rate is deduced from VMT growth

Ethanol

Lead Staff: Ben Hancock

Ethanol - *Background*

- Federal mandate – 2 % *(by weight)* for Oxygen content in gasoline. Primarily to reduce CO
- Requirement met – *by addition of 10% MTBE*
- MTBE – *suspected carcinogen mandatory phase-out by 2003*
- Replacement – *Ethanol 5.7%*
- Commingling – *potential increase in permeation losses*

E65 Ethanol Permeation Study

- 10 vehicle fuel systems (removed)
- Diurnal tests, MtBE fuel and EtOH fuel
- Vented canisters outside, measured permeation only, not vapor displacement or liquid leaks

Method Summary

- $$ER_{etoh} = ER_{mtbe} * (Frac_Evap_from_Permeation * Augmentation_Factor + Frac_Evap_from_Other_Losses)$$

$$ER_{etoh} = ER_{mtbe} * (PERMfr * EtRFG2r + (1-PERMfr))$$

Where:

ER = Emission Rate

$$EtRFG2r = Augmentation_Factor = \frac{Diurnal_Rate_etoh}{Diurnal_Rate_mtbe}$$

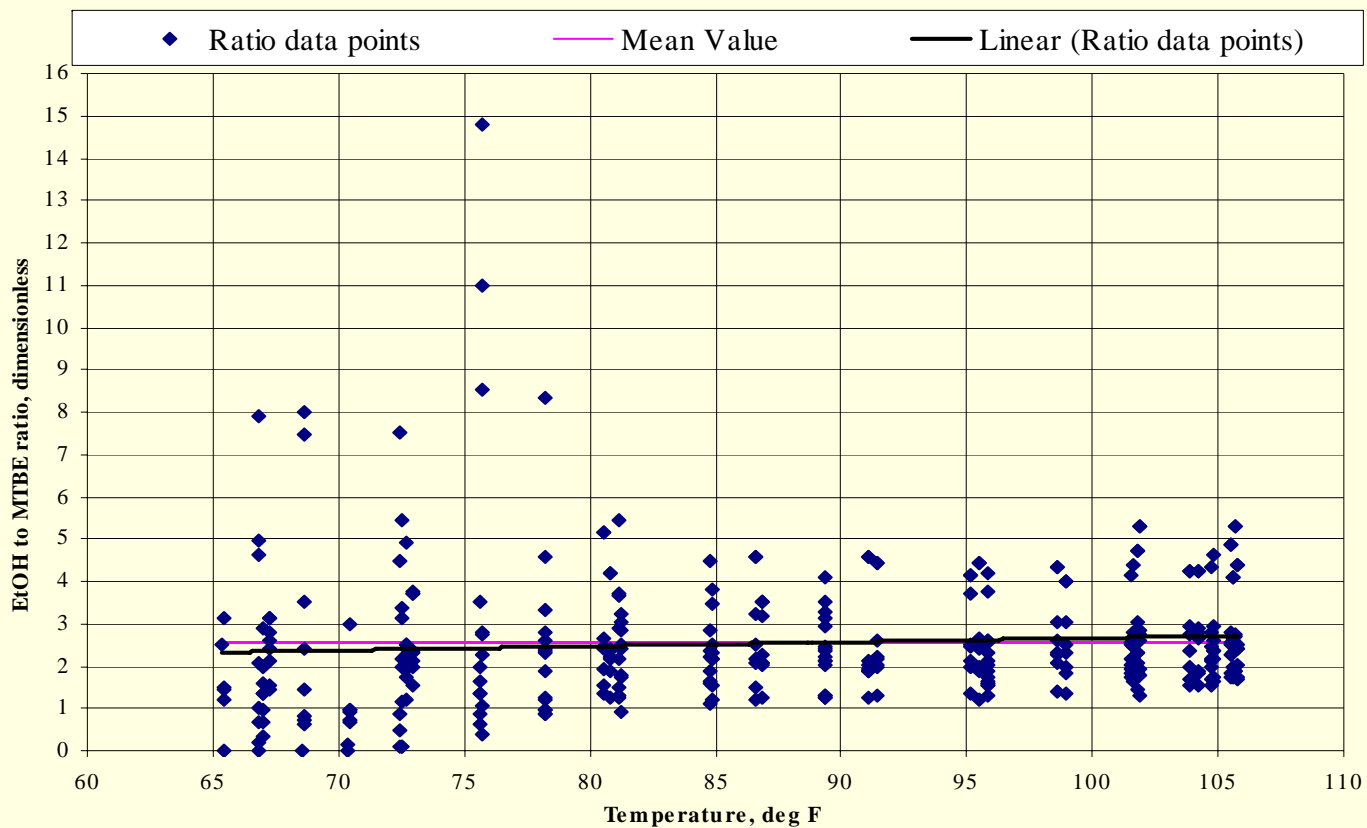
$$PERMfr = Frac_Evap_from_Permeation = 0.9 * \frac{(ER_{resting_loss} * RVPTCF)}{(ER_{process} * RVPTCF)}$$

- Hypothesized that resting losses are surrogate for permeation
- Augmentation ratios at ambient temperature

Ethanol Augmentation Ratio (EtRFG2r)

- Ethanol Augmentation Ratio was constant with respect to temperature – *when data segregated into normal and moderate emitter.*
- No Liquid Leakers were observed in the data set
- ARB-Stakeholder group - *currently the Augmentation Ratio for Liquid Leakers is 1.05 (will be changed to 1.02)*

Ethanol Augmentation Ratio EtRFG2r



Ethanol Augmentation Ratio (EtRFG2r)

Regime	EtRFG2r
Normal	2.55
Moderate	1.20
Liquid Leaker	1.05 (currently assumed) will change to 1.02

Permeation Fractions (PERMfr)

- Resting loss mostly permeation.
- Permeation fraction is 90% of resting loss divided by diurnal rate at temperature.
- Used the temperature dependence of EMFAC resting loss correlations developed from surveillance data in SHED.

Ethanol Summary

- Permeation primarily affects Diurnal and Resting Losses.
- Hot Soaks and Running Losses are primarily vapor, and are not significantly effected
- Approximately a 4% increase in ROG

Heavy-Heavy-Duty Truck Emission Rates

Lead Staff: Lei Zhou

HHDDT Base Emission Rates

- Improved Emission Rates
 - Revised using CRC E55/E59 chassis test data
 - Larger sample size (70 vs 23 trucks)
 - Included testing of 1999-2003 MYs
 - Projection for 2007+ rates based on 2003 MY instead of 1998 MY data

Comparison of Zero-Mile Rates

Model Year Groups	NOx (g/mi)		PM (g/mi)	
	EMFAC2002	Draft Model	EMFAC2002	Draft Model
1987-1990	16.8(4)	22.7(9)	0.84(4)	1.88(9)
1991-1993	16.0(3)	19.6(10)	0.51(3)	0.78(10)
1994-1997	19.1(5)	19.3(11)	0.32(5)	0.51(11)
1999-2002	13.4	18.9(8)	0.21	0.56(8)
2003-2006	6.68	12.5(4)	0.26	0.35(4)
2010+	0.67	1.14	0.026	0.035

- Rates in red: projected using ratio of standards
- Numbers in parentheses: number of trucks tested.

HHDDT NO_x

Emission Factor Comparison

Model Year Group	EMFAC2002 (g/mi)	EMFAC(wd) (g/mi)	Ratio (Ewd/E2002)
Pre-1975 to 1990	29.1 to 17.5	24.0	0.8 to 1.4
1991 to 2002	17.5 to 14.0	21.6	1.2 to 1.5
2003 to 2006	7.0	15.2	2.2
2007 to 2009	4.0	9.2	2.3
2010+ (w/OBD)	1.0	3.2 (2.7)	3.2 (2.7)

Reflects Base Emission Rates and Deterioration at 500,000 miles

Tampering & Malmaintenance Rates

- EMFAC2002 did not account for a variety of malfunctions in future year engines
- OBD designed to reduce frequency of failures
- Draft model accounts for benefits from OBD regulations

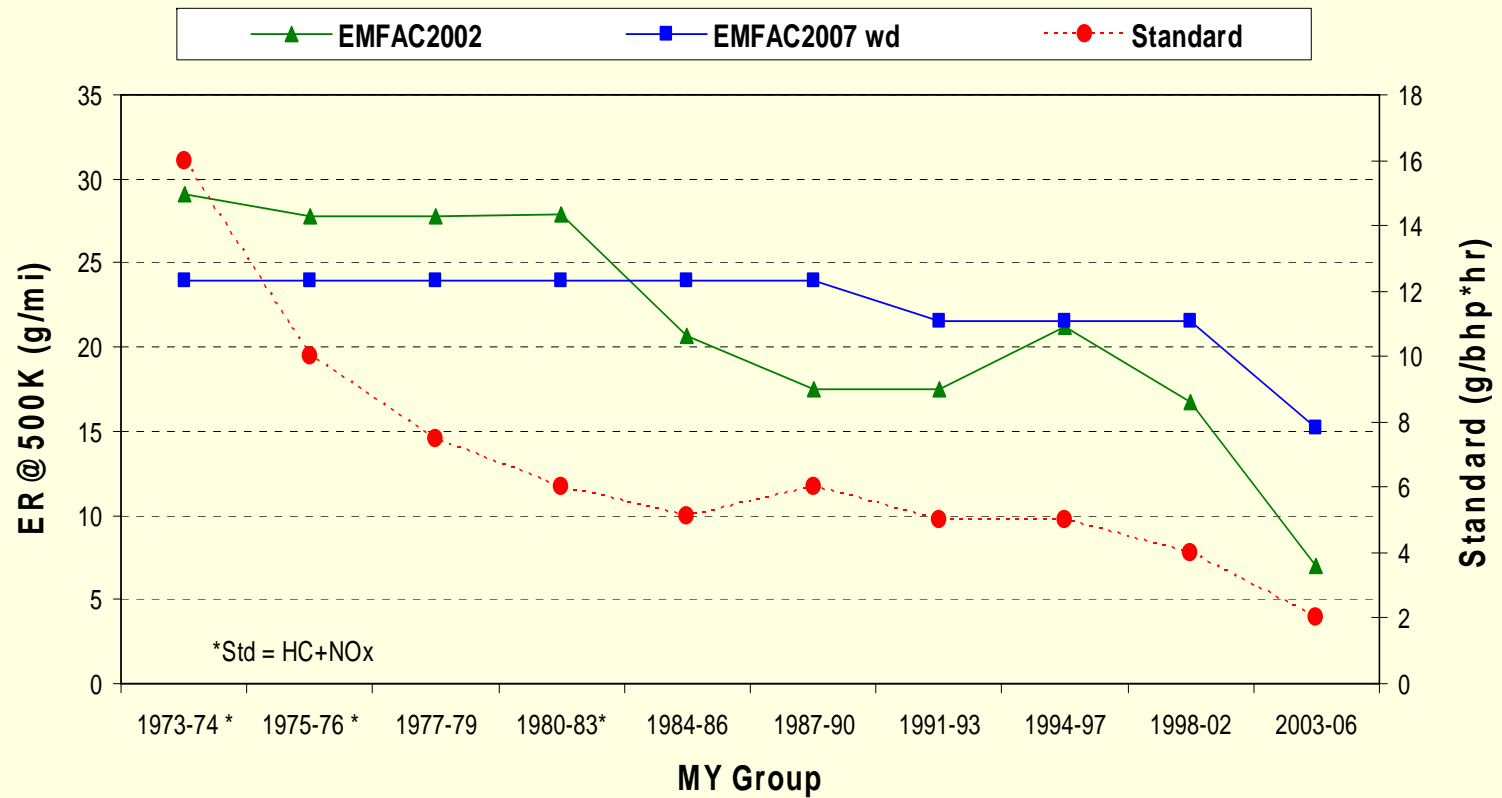
TM&M Frequency for 2010+ MYs

TM&M Act	EMFAC2002	EMFAC2007 wd	
	2003+	2010+ No OBD	2010+ w/ OBD
NOx Aftertreatment Sensor	n/a	53%	40%
NOx Aftertreatment Sensor (R)	n/a	2%	11%
NOx Aftertreatment Malfunction	n/a	17%	12%
PM Filter Leak	n/a	14%	10%
Electronics Failed	3%	30%	20%
Oxi Cat Malfunction/Removed	0%	5%	3%
EGR Disabled/Low Flow	15%	20%	13%

Comparison of NO_x Emission Rates at 500,000 Miles

Model Year Group	EMFAC2002 (g/mi)	EMFAC(wd) (g/mi)	Ratio (Ewd/E2002)
Pre1975 - 1990	29.1 - 17.5	24.0	0.8 - 1.4
1991 - 2002	17.5 - 14.0	21.6	1.2 - 1.5
2003 - 2006	7.0	15.2	2.2
2007 - 2009	4.0	9.2	2.3
2010+ (w/OBD)	1.0	3.2 (2.7)	3.2 (2.7)

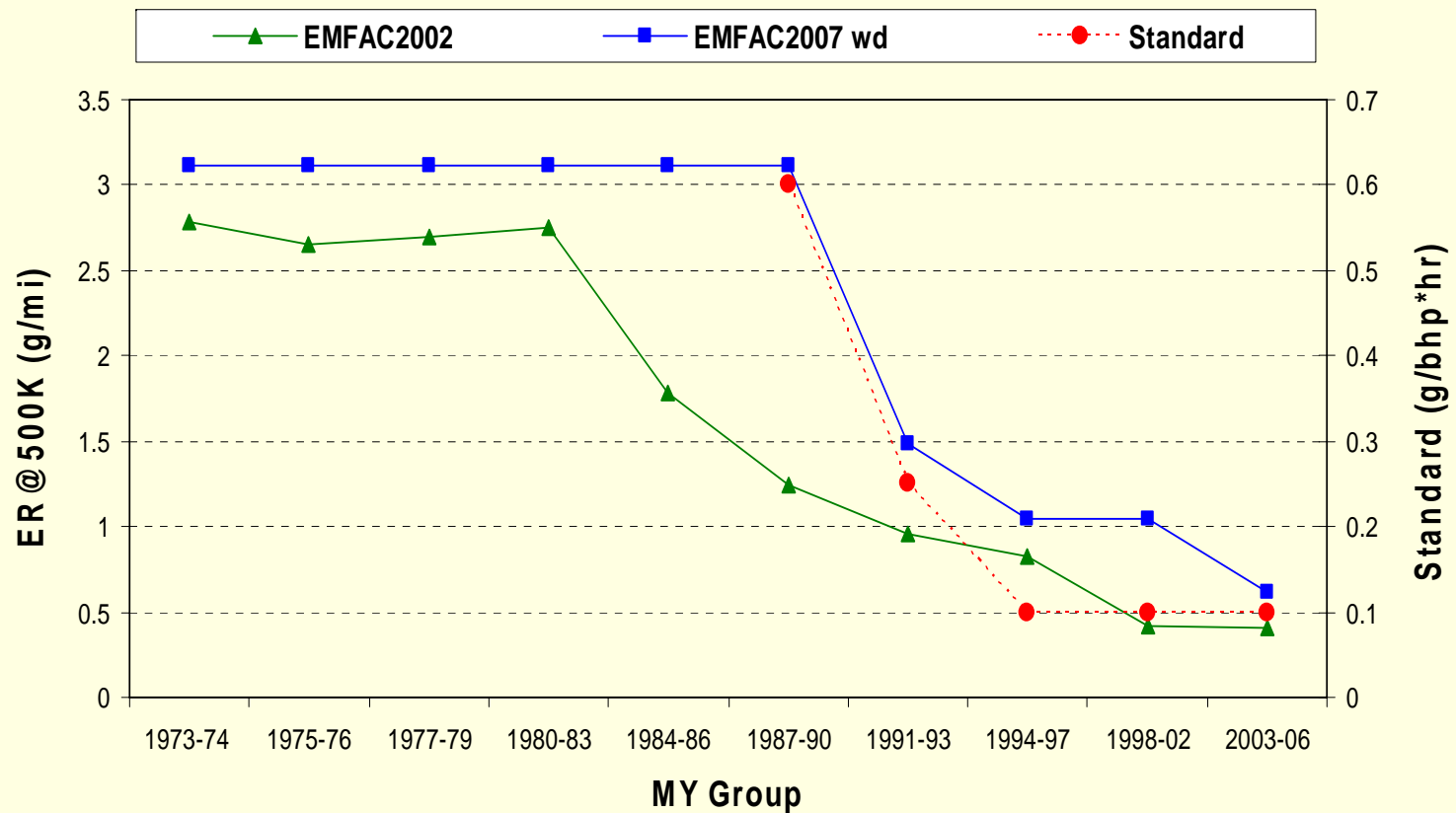
HHDDT NO_x Emission Trend



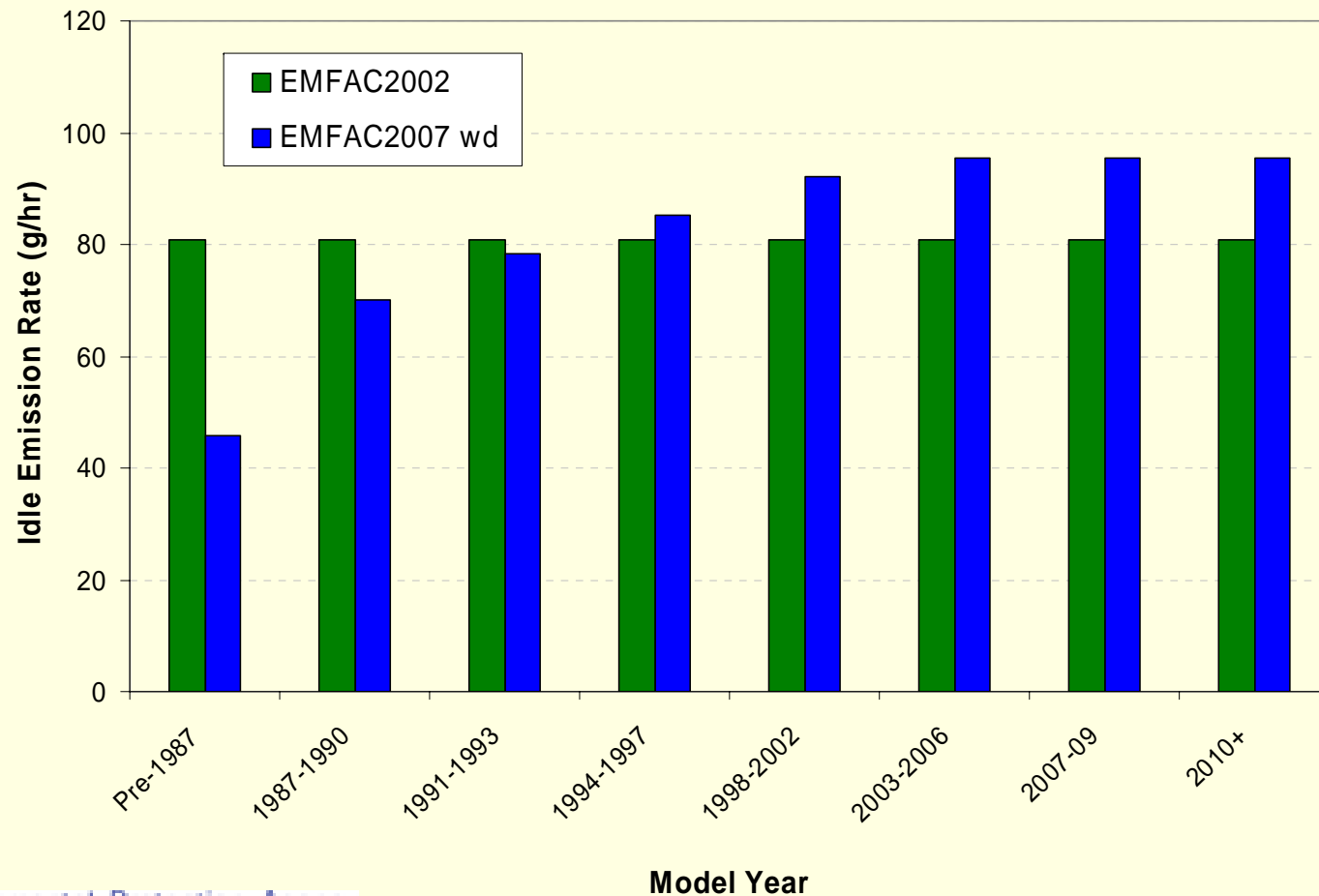
Comparison of PM Emission Rates at 500,000 Miles

Model Year Group	EMFAC2002 (g/mi)	EMFAC(wd) (g/mi)	Ratio (Ewd/E2002)
Pre1975 - 1990	2.78 - 1.24	3.11	1.1 - 2.5
1991 - 2002	0.96 - 0.36	1.49 - 1.05	1.6 - 2.9
2003 - 2006	0.41	0.62	1.5
2007 - 2009	0.18	0.09	0.5
2010+ (w/OBD)	0.18	0.09 (0.07)	0.5 (0.4)

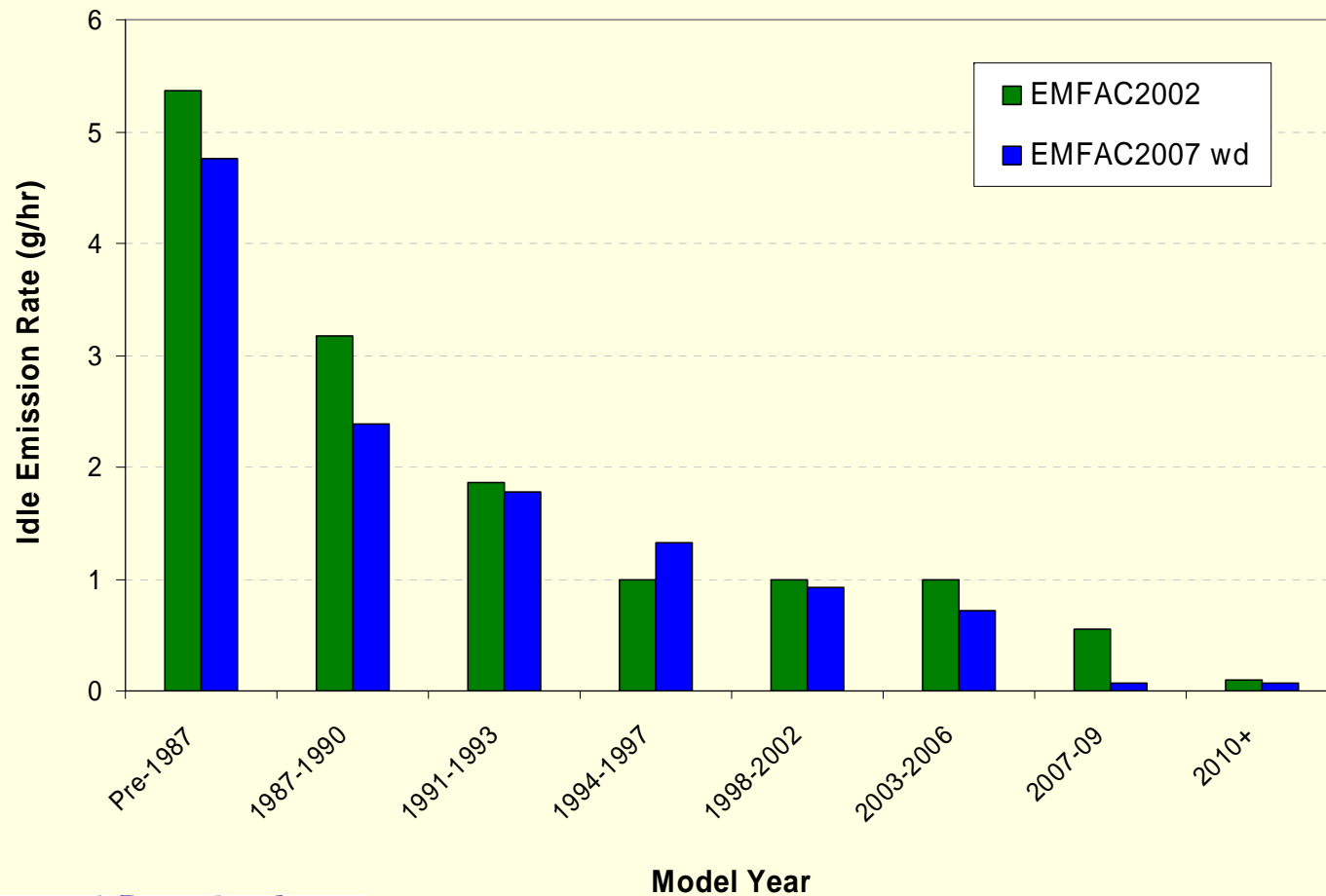
HHDDT PM Emission Trend



Comparison of NO_x Idle Emission Rates



Comparison of PM Idle Emission Rates



High Idle Emission Factors

	HC	CO	NO _x	PM	CO ₂
Summer	1.7	3.1	2.1	2.5	2.3
Winter	2.2	7.3	1.8	4.3	1.8

** Summer (Mar-Sep): 90°F, >800 rpm, A/C on.*

Winter (Oct-Feb): 0°F, >800 rpm, Heater on.

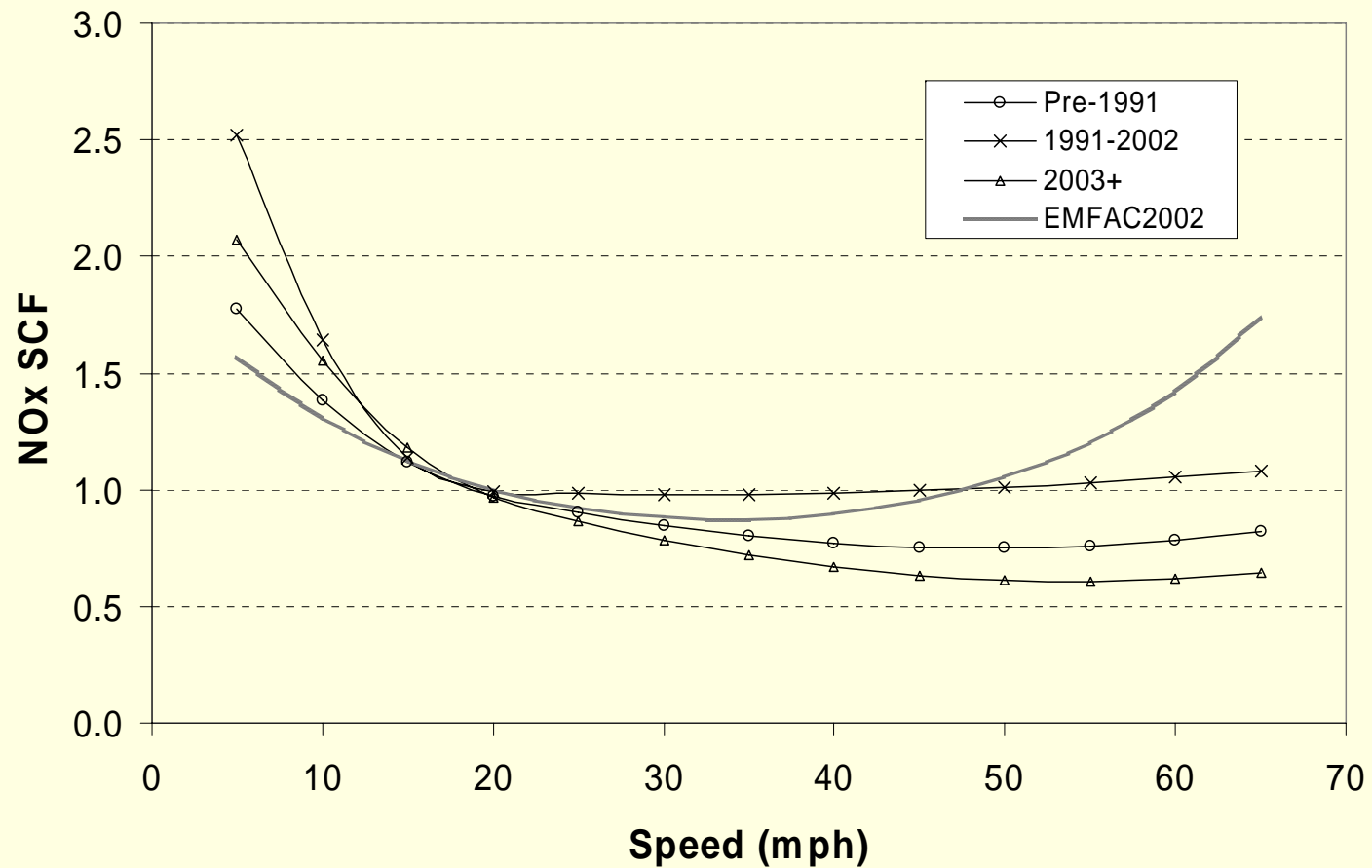
** Estimated typical idle mix: 61% low idle and 39% high idle.*

** Data Source: USEPA/ORNL, UCD.*

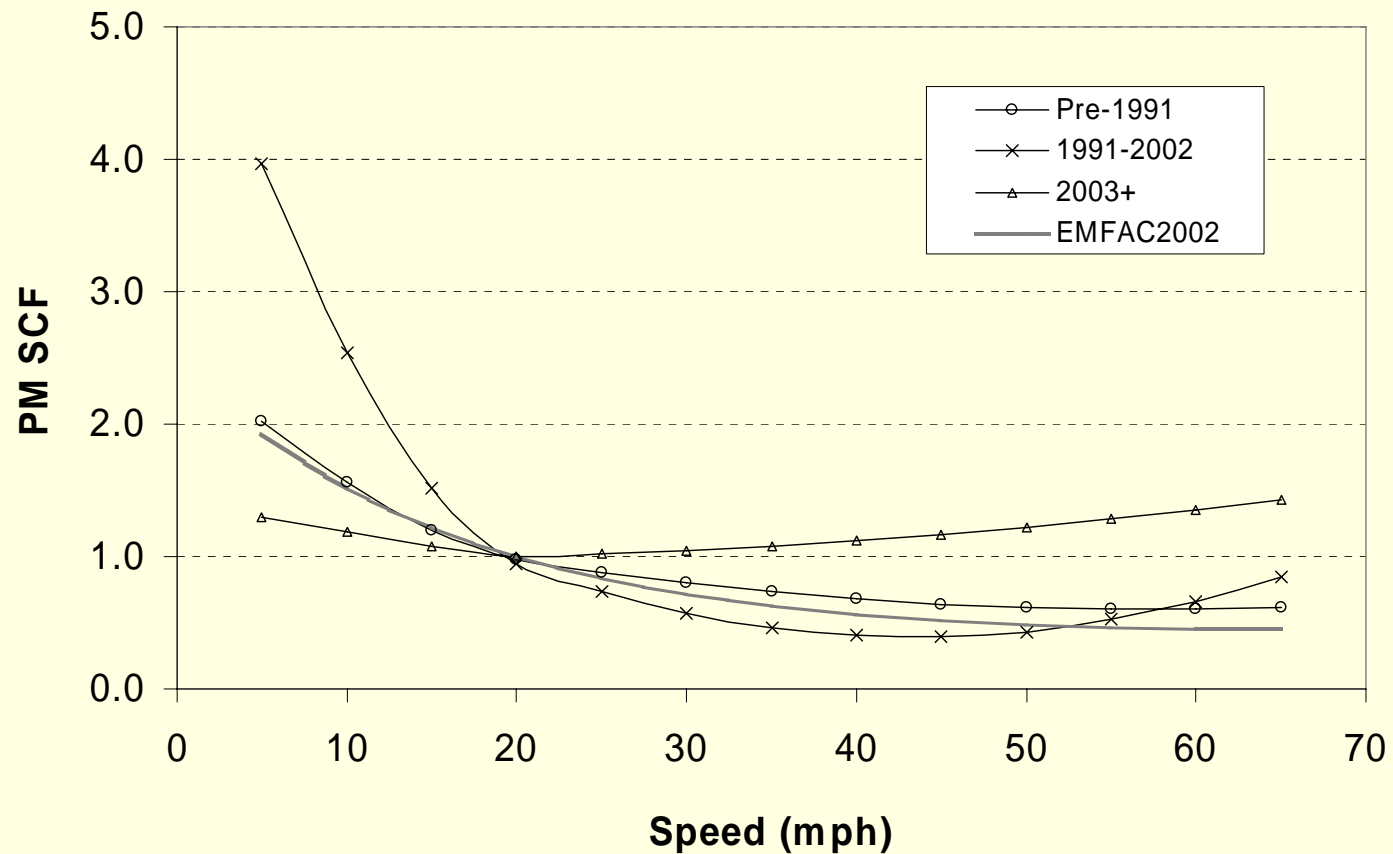
Speed Correction Factors

- Revised Speed Correction Factors – *Using CRC E55/59 data*
 - Three curves for Pre-1991 MY, 1991-2002 MY, and 2003+ MY
 - Reflect off-cycle NOx

NOx Speed Correction Factors



PM Speed Correction Factors



Future Work

- Extended Idle Regulations – *This will probably be an off-model adjustment*
- Chip Reflash – Issues
 - Lawsuit underway
 - Off-model adjustment

Temperature & Relative Humidity (Summer)

Lead Staff: Dilip Patel & Ben Hancock

Background - *Temperature and Relative Humidity*

■ EMFAC2002 Data

- California Irrigation Management Information System (CIMIS) 94 stations 1988-93
- California Department of Forestry (CDF) 1992-93
- National Weather Service (NWS)
- National Climatic Data Center (NCDC)

■ Monthly – *Extracted Hourly profiles for each area, which were population weighted*

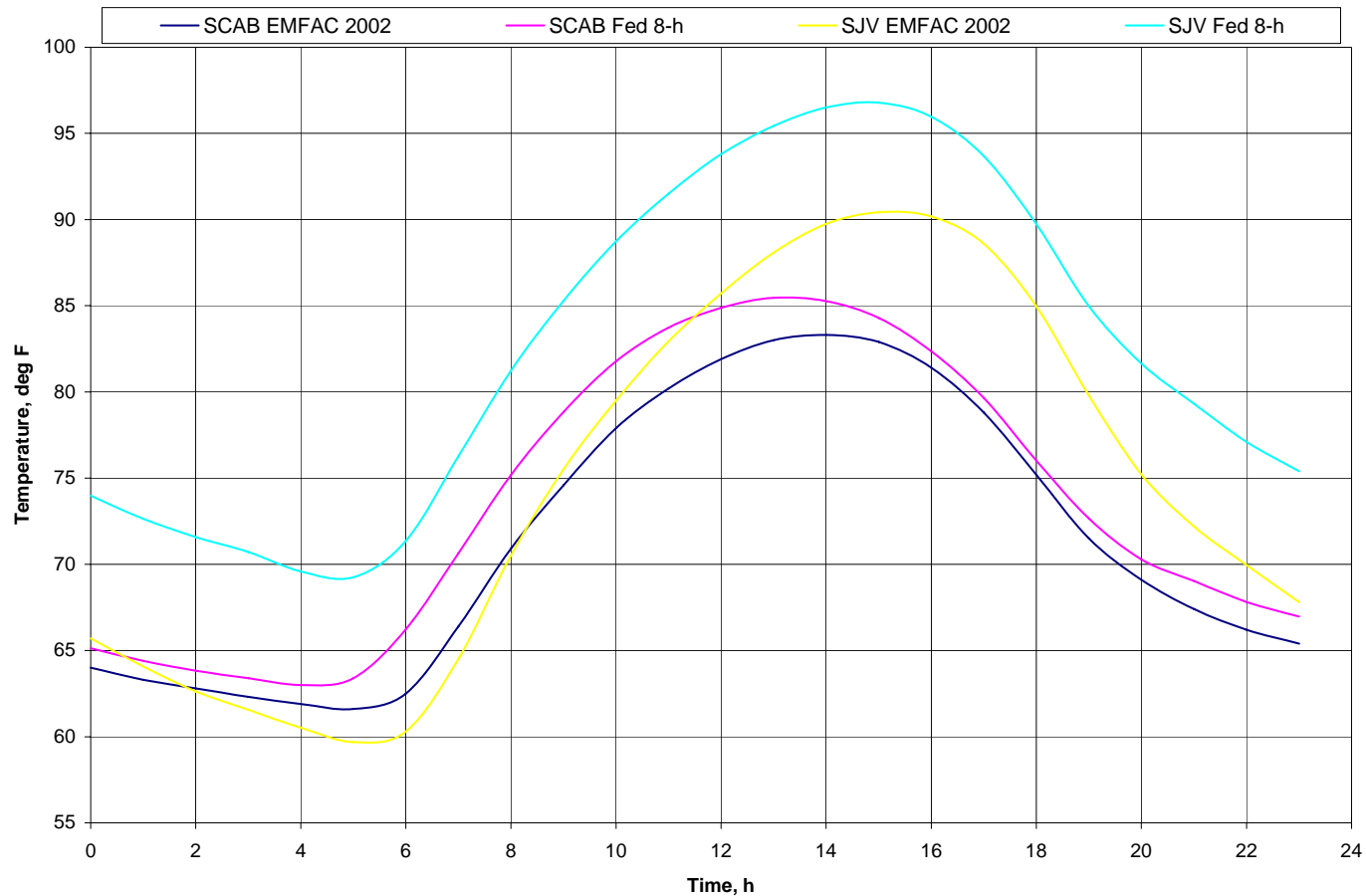
■ Summer Ozone - *Data for those dates corresponding to the documented high O3 days*

■ Winter CO - *Data for those dates corresponding to the documented high CO days*

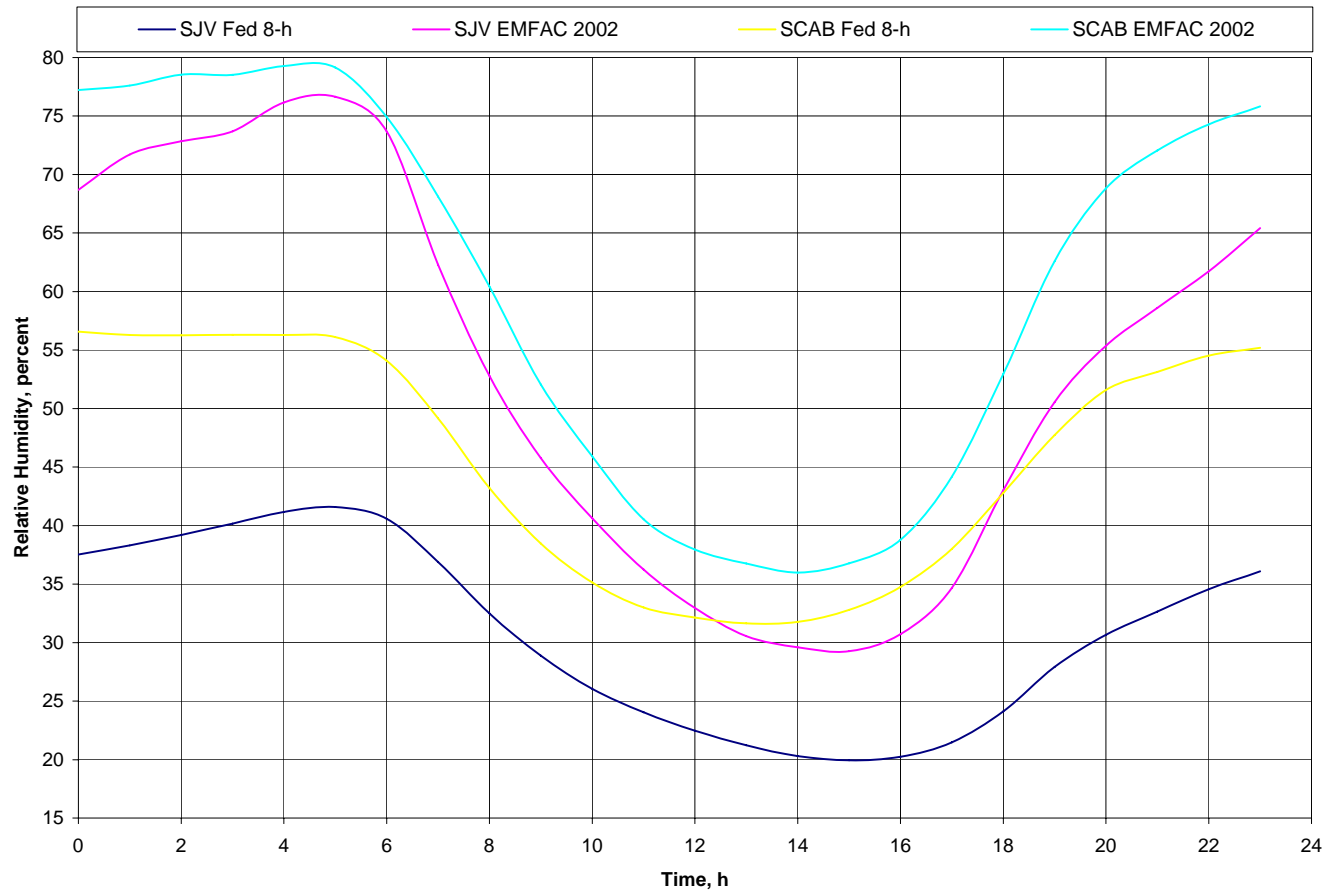
Reason for Updating Summer Profiles

- Federal 8-Hr O3 standard - *produce profiles that represent conditions that contribute to ozone levels that challenge the federal 8-hour ozone standard*
- Use of more recent (1996-2004) met. data
- Weight temperatures by VMT distributions within each grid - *better represents vehicular activity along roadways in contrast to previous methodology*
- Exclude CIMIS data – *potential bias since it is often located in cooler areas*

Summer Planning Temperature Profiles



Summer Planning Relative Humidity Profiles



Observations

- South Coast AB

- The new summer temperature profile is slightly higher
- The new relative humidity profile is less moist, more drier conditions

- San Joaquin AB

- The new summer temperature profile is significantly higher
- The new relative humidity profile is also more drier

Emissions Impact

- Absolute Humidity $H = RH (a + b \cdot T + c \cdot T^2 + d \cdot T^3)$

Where: RH = relative humidity

T = Temperature

- **Temperature Increase** – *results in HC & CO emission increases from evaporative and running processes. However, temperature change on its own results in an increase absolute humidity, and a decrease in NOx*
- **Relative Humidity Decrease** – *results in NOx increase due to a decrease in absolute humidity. Also lower HC & CO due to less AC usage*

Miscellaneous Fixes

Lead Staff: Dilip Patel

Bug Fixes

- Corrected how the Mexican vehicle population is backcasted and forecasted from the base year (1999). This impacts the vehicle populations in San Diego and Imperial counties (Minor)
- Corrected how the population of new vehicles is calculated in the first forecast year (2000) to ensure that it is based on the gas to diesel ratio in calendar year 2000, instead of 1999 (Minor)
- Changed code that limited the forecasted sales of new heavy heavy-duty vehicles (Major – VMT)
- Removed a portion of the code that capped the PM rates above a certain mileage for **all** heavy-duty trucks (Significant Increase PM)

Bug Fixes (-cont-)

- Changed the precision with which the model determines if vehicles in a given hour are experiencing a resting loss event or a diurnal event (Minor)
- Corrected the code so that a user selection for adding motorcycles to Inspection and Maintenance (I&M) programs is retained (Minor)
- Corrected an error in how temperature is referenced in calculating diurnal evaporative emissions in the EMFAC mode (Minor)

Regime Specific Evap Calculations

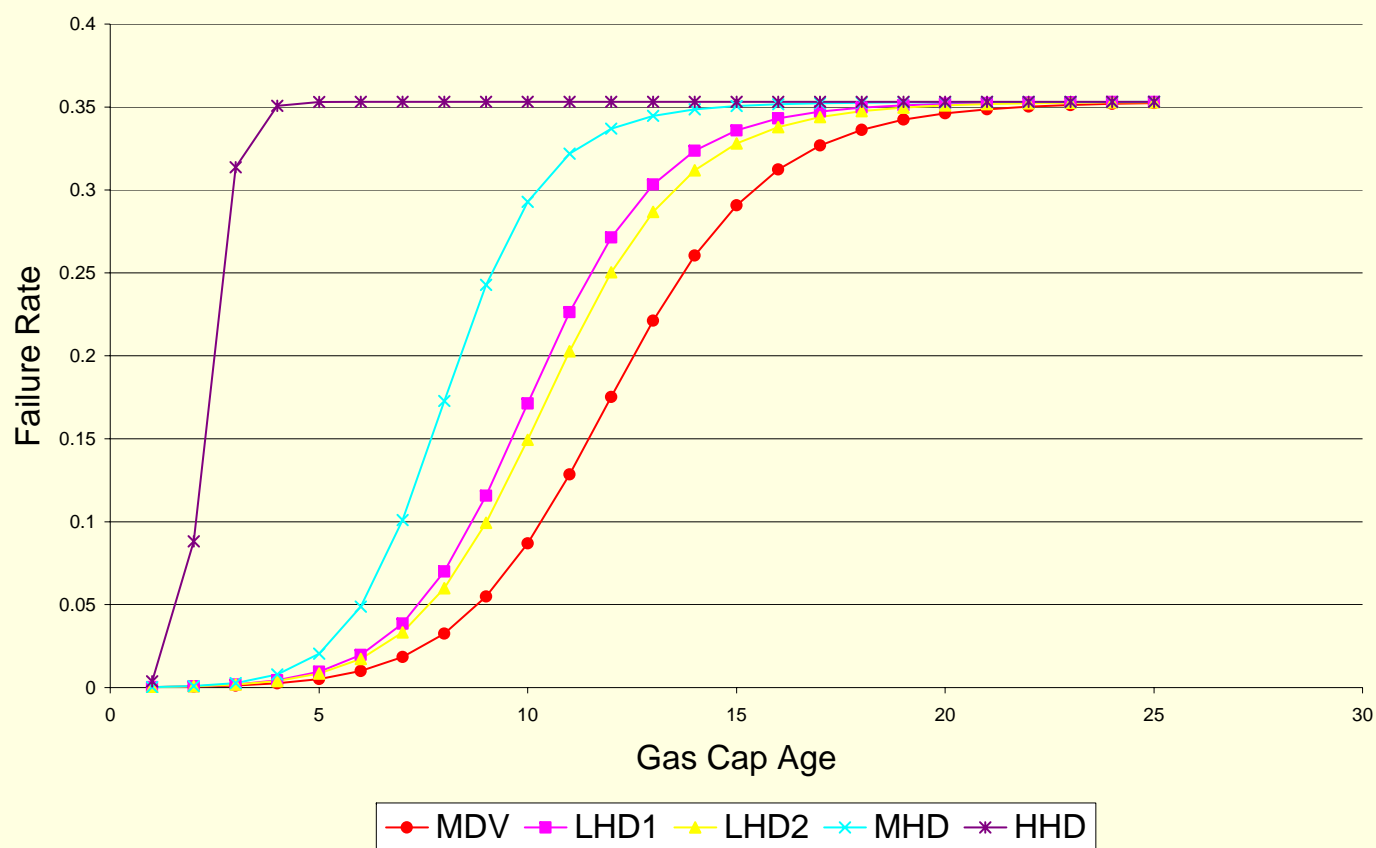
- Hot Soak evaporative emissions were being double adjusted for regime size.
- Minor Effect on Running Losses
- No Effect on Diurnal or Resting Losses

Heavy Duty Gas Cap Algorithm

- HDGT Gas Cap implemented in I/M in 1998
- Never implemented in EMFAC2000 series
- Implemented in EMFAC2007 Working Draft
- Substantial Evaporative Benefits ~ 25 tpd ROG
- Large benefits because
 - HDVG vehicles accrual mileage rapidly
 - Results in higher gas cap failures
 - Faster repair results in more benefits

Gas Cap Failure Rates

Figure 3 Gas Cap Fail Rate - Medium and Heavy Duty



Additional EMFAC2007 Changes

Additional Changes

Planned Changes to EMFAC2007

- HHDT Emissions – *Current WD has 2 SCF curves. This will be changed to 5 SCF. Potential significant increase in PM for future CYs*
- Ethanol – *Change liquid leaker augmentation ratio from 1.05 to 1.02. Minor impact ~0.5 tpd decrease*
- Population – *Change population estimates. Significant impact on activity and emissions*
- COG VMTs & Speeds – *Rematch previously submitted VMTs + incorporate additional submittals*
- Other

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